BRICKWORK. Lbs. per Sq. Inch.

Crushed with 15 tons 2 cwt. 0 qrs. 12 lbs. .. .. = 417

Mean 521

The average weight supported by these bricks was 33·5 tons per square foot, equal to a column 583·69 feet high of such brickwork.

SANDSTONE.

No. 6. 3-inch cube red sandstone, weighing 1 lb. 14½ oz., set between boards (made quite dry by being kept in an inhabited room).

Crushed with 8 tons 4 cwt. 0 qrs. 19 lbs. .. .. = 2043

No. 7. 3-inch sandstone, weighing 1 lb. 14 oz., set in cement (moderately damp).

Crushed with 5 tons 3 cwt. 1 qr. 1 lb. = 1285

No. 8. 3-inch sandstone, weighing 1 lb. 15½ oz., set in cement (made very wet).

Crushed with 4 tons 7 cwt. 0 qrs. 21 lbs. .. .. = 1085

No. 9. 6-inch cube sandstone, weighing 18 lbs., set in cement.

Crushed with 63 tons 1 cwt. 2 qrs. 6 lbs. .. .. = 3924·8

No. 10. 9½-inch cube sandstone, weighing 58½ lbs., set in cement (77½ tons were placed upon this without effect, = 2042 lbs. per inch, which was as much as the machine would carry).

Average crushing weight .. 2185

The average weight required to crush this sandstone is 134 tons per square foot, equal to a column 2351 feet high of such sandstone.

LIMESTONE.

No. 11. 3-inch cube Anglesey limestone, weighing 2 lbs. 10 oz. set between boards.

Crushed with 26 tons 11 cwt. 3 qrs. 9 lbs. .. .. = 6618

This stone formed numerous cracks and splinters all round, and was considered crushed, but on removing the weight about two-thirds of its area were found uninjured.

No. 12. 3-inch limestone, weighing 2 lbs. 9 oz., set between deal boards.

Crushed with 32 tons 6 cwt. 0 qrs. 1 lb. = 8039

This stone also began to crack and splinter externally with 25 tons (or 6220 per inch), but ultimately bore as above.

No. 13. 3-inch limestone, weighing 2 lbs. 9 oz., set in deal boards.

Crushed with 30 tons 18 cwt. 3 qrs. 24 lbs. .. .. = 7702·6

No. 14. 3 separate inch cube limestone, arranged in a triangle, weighing 4½ oz., set between deal boards.

Crushed with 9 tons 7 cwt. 1 qr. 14 lbs = 6995·3

All crushed simultaneously.

Average 7579

7338·5

The weight required to crush this limestone is 471·15 tons per square foot, equal to a column 6753 feet high of such material.

As to *slate*—a slab of slate 2 feet 10 inches broad, 4 inches thick, and 4 feet between the bearings, failed with 24½ tons distributed over 15 inches at the centre of the span. Cast iron of same dimensions would scarcely support five times as much, and would be 2½ times as heavy.

Experiments were made on the transverse strength of whole balks of American red pine timber.

"These beams were exactly 12 inches square and 17 feet long, the distance between the bearings being 15 feet. They were broken by actual weight suspended on a scale from the centre of the beams.

Dry timber from the butt end of the balk.

Weight of the beam, 5 cwt. 2 qrs. 5 lbs., or 36·5 lbs. per cubic foot.

Breaking weight, 14·82 tons.

Dry timber from the top of the balk.

Weight of the beam, 5 cwt. 17 lbs., or 33·9 lbs. per cubic foot.

Breaking weight, 13·24 tons.

The mean breaking weight of these two balks was therefore 14 tons, and from the formulæ $c = \frac{lw}{d^2}$, we have $c = 1·45$ ton; or, for the breaking-weight of any beam of such timber, we have $W = \frac{c\,d^2}{l}$ = 1·45 ton, the dimensions being all in inches."

It is interesting to trace the various modes of effecting certain objects which presented themselves. Thus Mr. Stephenson had at one time determined to erect the tube, in situ in the following manner:—

"He proposed, 1st, To construct a suspension-bridge of sufficient strength to carry the tube and any load that might be required; the platform or roadway of this bridge being at the intended level of the tubes.

2ndly. To prepare platforms at the same level at each approach of the suspension-bridge, and on these platforms, as well as across the suspension-bridge, to lay double railway.

3rdly. To construct the tube on the railway on a line of trucks moveable bodily on wheels or rollers.

4thly. To load the suspension-bridge with a distributed weight, about equal to the intended tube, supported on a line of trucks on the suspension-bridge.

And lastly. To draw the tube thus supported on to the bridge at one end simultaneously with the withdrawal at the other end of the line of loaded trucks, so as to prevent any great undulation in the suspension-bridge."

Returning, however, to the bridge as erected, the Britannia Tower is 221 feet 3 inches high, with a batter of 1 in 36 on all sides. It contains 151,158 cubic feet of Anglesey limestone, 127,001 cubic feet of Runcorn sandstone, and 68,411 cubic feet of brickwork, in all weighing 24,700 tons. Including the bed-plates it contains also 479 tons of cast iron, and the weight from the two tubes will be about 4,000 tons. The total weight at the foundations is thus 29,600 tons, or 16 tons per superficial foot of sectional area; whereas the weight required to crush the lower courses would be about 500 tons per superficial foot.†

The annexed engraving is a view of the approach to the bridge, and of the Island of Anglesea, from the Britannia tower.

Over the entrances to the tubes are massive lintels, consisting of single stones, 20 feet long, and the approaches are marked by colossal lions couchant on pedestals,—a view of one of which is annexed. These lions were designed by Mr. Thomas, of the New Houses of Parliament, and are each composed of 11 pieces of limestone; they are each 25 feet long, 12 feet high, and weigh about 30 tons. It is stated, as an illustration of the perfection of the scaffolding employed, that one of these lions was brought from a workshop at the base of the abutment, raised 100 feet, and put together complete on the pedestal in a single day.

The Britannia Bridge contains altogether 1,499,151 cubic feet of masonry, weighing 104,875 tons. During two years and nine months the masonry has been set at the rate of 3 cubic feet per minute. The wrought-iron roadways weigh 9,360 tons; and the cast-iron used weighs 1,987 tons. The cost of the bridge, when nearly complete, was estimated as approximately as it could be ascertained as follows:—

Pedestals, wing walls, Carnarvon	£17,159	
Carnarvon Tower	28,526	
Britannia Tower	38,671	
Anglesey Tower	31,136	
Pedestals, wing walls, Anglesey	40,170	
Lions	2,048	
		158,704
Wrought iron used in tubes	116,946	
Cast iron in tubes and towers	80,619	
Construction of tubes	226,824	
Pontoons, ropes, anchors, painting materials, &c.	28,096	
Raising machinery	9,782	
Carpentry and labour in floating, raising, and completing the bridge	25,498	
Experiments, proportional part of the whole	3,966	
		643,161
Total		£801,865

Some of the *acoustic* effects produced by the bridge are interesting. The report of a gun fired beneath the bridge is repeated three or four times. The rapid repetition of echoes from each of the T irons on the side of the tube gives rise to a shrill, whirring musical note. When any violent noise is produced on the adjacent shore, the note is the same whether produced by the blows of the riveters or the report of a cannon, and corresponds to the low D on a concert flute. The cells of the top and bottom form excellent speaking tubes, and conversation may be carried on through them even in a faint whisper. By elevating the voice persons may converse through the entire length of the bridge, a distance of more

* To enable the reader to compare this suspension-bridge with other similar structures, we have inserted some details of well-known suspension-bridges:—

Bridges.	Span. Feet.	Area of chain in Square Inches.	Weight. Tons.	Total Wt. Tons.
Menai	560	360	40	[illegible]
Conway	327	130	21·3	[illegible]
Hungerford	676	[illegible]	[illegible]	[illegible]
Clifton	703	450	30	[illegible]
Hammersmith	422 10	180	[illegible]	[illegible]
Peesh	[illegible]	[illegible]	[illegible]	[illegible]

Stone work, &c. [illegible]

Cast-iron [illegible]

Two tubes, dry [illegible]

Junction and fastenings [illegible]

Area of tubes in tons, [illegible]

† The total cost of the experiments was £[illegible]

‡ The cost of the railway work on the Britannia Bridge is 5 per cent., may be called 6 per cent. In various places in the world, the cost of the railway work is [illegible] as the whole line depends, will [illegible] from [illegible] the consideration of [illegible]